Abstract

Global warming is currently a major challenge facing the world. There are widespread ongoing efforts in the form of summits, conferences, etc., to find satisfactory ways of surmounting this challenge. The basic objective of all such efforts can be summarized as conception and formation of protocols to reduce the pace of global carbon levels. Game theory and mechanism design provide a natural modeling tool for capturing the strategic dynamics involved in global warming related problems. This dissertation explores for the first time the use of voting mechanisms in the context of solving the central problems, namely, allocation of emission caps and reduction quotas to strategic emitting agents (countries).

The contribution of this dissertation is two-fold. The first contribution is to develop an elegant game theoretic model that accurately captures the strategic interactions among different emitting agents in a global warming setting. This model facilitates a convenient way of exploring a mechanism design approach for solving important allocation problems in the global warming context. The second contribution is to propose and explore a novel approach, based on voting mechanisms, to solve two problems: (1) allocating emission caps and (2) allocating reduction quotas to strategic agents.

Our work investigates the use of voting mechanisms that satisfy four desirable properties: (1) non-dictatorship, (2) strategy-proofness, (3) efficiency, and (4) anonymity. In particular, we explore the median selection, maximum order statistic selection, and general K^{th} order statistic selection voting mechanisms. Our results clearly show that only trivial allocations satisfy all the above properties simultaneously. We next investigate the use of voting mechanisms for the dual problem, namely, allocation of emission reductions to emitting agents. Here, we show that non-trivial allocations are possible, however an important property, individual rationality, might be compromised.

The investigations in the thesis bring out certain limitations in applying voting mechanisms that satisfy all the four properties above. Nevertheless, the insights obtained provide valuable guidelines for solving emission allocation related problems in a principled and informed way.